Chesapeake Bay Nontidal Water-Quality Sampling Progress Report

Calendar Year: 2009

Executive Summary

In the landmark document *Chesapeake 2000*, the Chesapeake Bay Program (CBP) and its partner State and Federal agencies agreed to improve water-quality in the Bay by meeting water-quality criteria for dissolved oxygen, water clarity and chlorophyll *a* by 2010 (CBPO, 1999). More recently, a strategy for protecting and restoring the Chesapeake Bay Watershed was released in response to the Executive Order 13508 issued in 2009. This Executive Order set into action a new era of federal leadership, action and accountability for protecting and restoring the Chesapeake Bay Watershed. Included in the Executive Order strategy are annual action plans, progress reports as well as two-year milestones for improving water quality, recovering habitat, sustaining fish and wildlife, and conserving land and increasing public access. In the water quality realm, the Executive Order states that water quality in the Bay and its watershed continue to be in poor condition, pointing to the need for significant reductions in nitrogen, phosphorus, sediment, and chemical contaminates. The Executive Order sets outcomes for water quality improvement in the Bay and its watershed to be met by 2025 (FLC 2010). The CBP nontidal watershed water-quality network is an essential component to this strategy, as it provides the data for all analysis and communication of the status and changes in water quality conditions within the Chesapeake Bay Watershed.

The Chesapeake Bay Program designed the nontidal watershed water-quality sampling network in 2004 and signed a memorandum of understanding in September of 2004 to implement the network (CBP, 2004). After a review of the monitoring network in 2009, the original objectives of the Chesapeake Bay nontidal water-quality network were modified. These new objectives reflect a balance between the long-term monitoring goals of CBP partners and the increased need for tracking changes that may result from management actions (restoration) and other changes occurring within the watershed. The new objectives as determined by the CBP monitoring realignment action team (MRAT) are the following:

- Measure and assess the status and trends of nutrient and sediment concentrations and loads in:
  - Major tributaries and sub watersheds
  - Selected tributary strategy basins;
- Provide data suitable for the assessment of factors affecting nutrient and sediment status and trends from major pollutant source sectors;
- Measure and assess the effects of targeted management and land-use change;
- Improve calibration and verification of partners' watershed models;
- Support spatial and topical prioritization of restoration and preservation;

(MRAT 2009)

Of the 200 proposed sites for the network, 67 sites (34 percent) have been fully implemented (known as primary sites), with another 18 sites partially implemented (known as secondary sites) as of the end of 2009. Approximately $3 million of mostly

existing funds, with another $300 thousand from the CBP, were used to implement the network by enhancing existing and establishing new monitoring sites. It is expected that the funds sustained through the CBP will increase in FY10. While progress has been made implementing the network, the goals of the network (above) will be restricted to areas where the monitoring sites have been implemented, and trend analyses can be done (requiring at least 5 years of data). The relatively small number of monitoring sites currently implemented will limit the ability of resource managers to assess the effectiveness of management actions designed to improve water-quality in the watershed and the tidal waters of the Bay.

Purpose

This document is the sixth in a series of annual reports that review the status of sampling efforts in the Chesapeake Bay nontidal water-quality network. It was written to collate and synthesize water-quality sample and stream flow gage information from data providers in the Chesapeake Bay Program. This 2009 calendar year (CY) report includes information about:

- the location of active water-quality stations and stream-flow gages
- the number of samples collected
- funding sources
- sampling challenges
- anticipated network alterations
- future sampling and analysis activities

Justification for the Nontidal Water-Quality Sampling Network

The Executive Order strategy for protecting and restoring the Bay Watershed states that water quality in the Bay and its watershed continue to be in poor condition, pointing to the need for significant reductions in nitrogen, phosphorus, sediment, and chemical contaminates. The Executive Order sets outcomes for water quality improvement in the Bay and its watershed to be met by 2025 (FLC 2010). The CBP nontidal watershed water-quality network is an essential component to this strategy, as it provides the data for all analysis and communication of the status and changes in water quality conditions within the Chesapeake Bay Watershed.

Objectives of the Nontidal Water-Quality Sampling Network

The original objectives of the Chesapeake Bay nontidal water-quality network were to: (1) measure and assess the status and trends of nutrient and sediment concentrations and loads in the tributary strategy basins across the watershed, (2) help assess the factors affecting nutrient and sediment status and trends, and (3) improve calibration and verification of partners' watershed models (CBPO, 2004). These original objectives were modified in 2009 in response to the MRAT evaluation of the CBP's water-quality monitoring networks (MRAT 2009). The new objectives reflect a balance between the long-term monitoring goals of CBP partners and the increased need for tracking changes that may result from management actions (restoration) and other changes occurring within the watershed. The new objectives are the following:

- Measure and assess the status and trends of nutrient and sediment concentrations and loads in:
  - Major tributaries and sub watersheds
  - Selected tributary strategy basins;
- Provide data suitable for the assessment of factors affecting nutrient and sediment status and trends from major pollutant source sectors;
- Measure and assess the effects of targeted management and land-use change;
- Improve calibration and verification of partners' watershed models;
- Support spatial and topical prioritization of restoration and preservation;

Original Network Design and Site Criteria

Sites that provide data to help meet the original objectives of the network were defined as primary sites. All primary sites must have (1) continuous stream flow gaging, (2) 20 water chemistry samples collected annually over a range of stream flow conditions (i.e., 12 base flow and 8 storm flow), (3) nitrogen, phosphorus and sediment analyses, and (4) collection techniques that ensure representative samples. The CBPO (2004) report also discussed implementation of secondary sites, where storm sampling was not conducted but all of the other requirements for a load site were met. However, these sites might be of limited value because loads can not be computed, only a limited number of newly developed trend tests can be conducted, and data are less useful for models. These secondary stations could be converted to primary stations when resources become available. The CBP (2004) report contains a list of 188 candidate sites for the network. The number was later increased to 200 sites to address the needs of New York. Approximately half of the sites had some existing data collection and the remainder did not. From the candidate sites, 87 were identified in 2004 to be implemented as a primary (54) or secondary sites (33).

A detailed analysis of the current network was conducted by the CBP MRAT in reference to both historical and revised objectives. This analysis revealed both strengths and weaknesses in the network. One of the original drivers for the design of the network was to capture monitoring sites within tributary strategy basins across the watershed. The Chesapeake Bay Watershed tributary strategy basins are composed of nine major tributary basins that are further divided into thirty-six smaller basins based on political jurisdictions. Designing a monitoring plan around these regulatory-determined basins has proven impractical and has created gaps in monitoring sites that target source sectors and smaller watersheds (MRAT 2009). The scope of the revised objectives for the nontidal network suggests that stream monitoring locations must represent a wide range of sizes and physical settings. The recommendations given for the design of the network can be found under the section "Future Network".

Funding and Implementation of the Network

Implementation of the network has been funded using a combination of Federal and regional partner funding sources. In fiscal year 2004, the Chesapeake Bay Program began funding agencies to develop the nontidal water-quality network. In 2009, it is estimated that the cost of the gages and water-quality sampling totaled nearly $3.5 million for 85 sites (67 primary sites and 18 secondary sites) (Figure 1). The Chesapeake Bay Program supported the network sampling with grants totaling about $300 thousand (9 percent of the total cost). The CBP water-quality monitoring program has been under review since 2008 and it is possible that FY10 CBP funding for the non-tidal water quality monitoring network will be modified from 2009 levels (Table 1). The funding strategy used to maintain the network relies on support from sources not closely allied with the network. These partners are primarily stream gage funding cooperators with various reasons for supporting network gages. While this fact makes the network less susceptible to budget fluctuations within any particular agency, it presents challenges for the long-term maintenance of stream flow gage data. Planning for the network's future can be

hampered by funding priorities of gage supporters for reasons not associated with the goals of the network.

Table 1. Estimated water-quality sampling network and flow gage costs for the calendar years of 2009 and 2010.

		Estimated Costs			
		2009		2010	
State	Collection Agency	Primary Site (x $1000)	Secondary Site (x $1000)	Primary Site (x $1000)	Secondary Site (x $1000)
Delaware	DEDNREC	92	0	92	0
Maryland	MDDNR	598	0	598	0
	USGS	184	0	184	0
New York	SRBC/NYDEC	230	0	230	0
Pennsylvania	PADEP/SCRO	276	0	276	0
	USGS	138	0	138	0
	SRBC	828	0	828	0
Virginia	VADEQ		468		468
	VADEQ/USGS	552	0	552	0
West Virginia	WVDEP/USGS /WVDA	184	0	184	0
Total	All	3,082	468	3,082	468

Costs are annualized and are based on the assumptions that primary stations cost $46 thousand and secondary stations cost $26 thousand (i.e., cost without storm sampling).

Summary of 2009 Water-Quality Sampling Efforts

The water-quality sampling network included 85 stations during the calendar year of 2009 (Table 2).

Table 2. Samples collected at stations that implemented CBP methods during calendar year 2009.

State	Collection Agency	# Primary Stations	Primary Samples/Goal (% Goal)	# Secondary Stations	Secondary Samples /Goal (% Goal)
Delaware	DEDNREC	2	28/40 (70%)		-
Maryland	MDDNR	13	265/260 (102%)		-
	USGS	4	82/80 (103%)		-
New York	SRBC/NYSDEC	5	76/100 (76%)		-
Pennsylvania	PADEP/SCRO	6	86/120 (72%)		-
	USGS	3	47/60 (78%)		-
	SRBC	18	273/360 (76%)		-
Virginia	VADEQ	0	-	18	215/216 (99.5%)
	VADEQ/USGS	12	264/240 (110%)		-
					-
West Virginia	WVDEP/USGS /WVDA	4	62/80 (78%)		-
Total	All		1183/1340 (88%)		215/216 (99.5%)

Sampling effectiveness was evaluated for all stations that used CPB methods during 2009. Effectiveness is defined as the number of water-quality samples collected relative to the recommendations for primary (12 interval samples and 8 high flow samples) and secondary (12 interval samples) sampling sites. Approximately 1,398 water samples were collected and analyzed from sites using CBP methods in 2009, this represents 90 percent of the number of samples targeted for collection and an 8 percent decrease from the number of samples collected in 2008. Overall, sampling success was higher for secondary sites (99.5 percent) than for primary sites (88 percent), albeit primary sites represented 86 percent of the total possible number of samples that was targeted. Primary sites are more difficult to achieve sampling success due to the unpredictable nature of the storm event sampling required at these stations. The decrease in sampling success from 2008 to 2009 can be attributed to the inability of monitoring organizations to sample during an adequate number of rainfall events.

Challenges and Solutions

The nontidal sampling network was initiated in the fall of 2004 and many agencies in charge of the sampling efforts in their jurisdiction still need to coordinate among several agencies. For instance, the USGS office in Richmond and the Virginia Department of Environmental Quality (VADEQ) cooperatively sample one station, the USGS samples another 11 stations, and VADEQ samples the remaining 18. Similarly, the Maryland Department of Natural Resources (MDDNR) and the USGS sample 13 and 4 stations, respectively. West Virginia samples four stations but does so collaboratively among the West Virginia Department of Environmental Protection, USGS, and the West Virginia Department of Agriculture. Moreover, while the Pennsylvania Department of Environmental Protection (PADEP) coordinates with the USGS and the Susquehanna River Basin Commission (SRBC), SRBC also shares sampling duties with New York State Department of Environmental Conservation (NYSDEC). It is clear that a great deal of coordination is required to monitor the non-tidal network.

Access to sampling sites was cited as another issue affecting sampling effectiveness. Many of the sampling sites are located at road/river bridge crossings where repair and construction often interfere with monitoring efforts (e.g. Potomac River at Chain Bridge has bridge construction making it inaccessible for sampling since August, 2009). Safety issues also arise during winter where snow and ice create a unique set of sampling challenges particularly for the most northern sites. The blizzard that occurred throughout the region at the end of the year made it hard to negotiate sampling; the storm was so wide-spread that it was also hard to incorporate monitoring to assess the impact of that snowmelt on water-quality.

Logistical constraints such as travel time between stations continue to be important considerations for sampling crews. For example, SRBC conducts much of the water chemistry sampling for Pennsylvania's 27 sites and New York's 5 sites but sampling must be coordinated among 4 agencies (USGS, PADEP, SRBC, and SCRO). SRBC sites are distributed within a 25,000 square mile portion (nearly 40 percent) of the Chesapeake Bay Watershed. Moreover, samplings that coincide with elevated discharge events create far greater challenges particularly among rivers draining different physiographic regions and drainage areas. Another logistical challenge comes with some stream gages that do not update frequently enough to enable the correct timing for sampling high flow events (e.g. Deer Creek and Gunpowder River in MD). It is also the case that in some areas of the watershed it was a relatively dry year, posing problems with collecting an adequate number as well as type of representative storm flow samples.

The water-quality network relies on continuous funding for discharge gage operations and these gages require funding and personnel resources. The cost of stream gages increased in FY09 while funding for stream gages has declined at the Federal and State level. The potential loss of these gages can jeopardize ongoing and future water-quality sampling. Many states have also experienced budget shortfalls in the last year leading to loss of experienced staff to carry out the monitoring; this has primarily affected the ability of organizations to conduct an adequate amount of storm flow sampling. Furthermore, while progress has been made in implementing the network, only about 1/3

of the proposed candidate sites were fully operational (67 primary sites) by the end of 2009. The majority of the implementation was accomplished by using existing funds from multiple partners. Any additional sites in the network will require new funding. Therefore, the primary goal of the network to assess the status, trends, and loads of nutrients and sediment throughout the watershed will only be limited to areas where the monitoring sites have been implemented and have at least 5 years of data. The lack of monitoring sites will limit the ability of resource managers to assess the effectiveness of management actions to improve water- quality in the watershed and the tidal waters of the Bay.

Future Network

While progress has been made in implementing the network, only about 1/3 of the proposed candidate sites were fully operational (67 primary sites) by the end of 2009; however, there are plans for new sites to be added in 2010 as recommended by the CBP review of the nontidal monitoring program. While much of the difficult technical work for design and sampling procedures has been completed, funding constraints will limit the future implementation of the network. Recent recommendations from the CBP monitoring review underscore both the importance of maintaining the existing network and improving its representativeness. As part of the evaluation of the CBP water-quality networks, a detailed analysis of the current network has been conducted in reference to both historical and revised objectives. The results of this analysis included the below recommended changes to the network; these recommendations will be used to determine the location of any new network sites as funding becomes available:

- Add more monitoring sites to address selected under-represented source sectors: urban and suburban
  - more analysis of other under-represented land uses and source sectors may be needed (long-term need)
- Add more monitoring sites to address small watersheds
  - add these sites based on existing or proposed intensive small watershed investigations, or if possible, based on focused BMPs or point source controls. Possible intensive small watershed investigations to partner with include the studies in watersheds identified by STAC that will have increased implementation funded through the Farm Bill (Weller et al. 2010).
  - consider different sampling frequency and load estimation techniques for smaller watershed sizes. Use of real-time water-quality surrogates is likely to be very useful here. Link directly with water pollution abatement actions.
- Add more monitoring sites to coastal plain physiographic region to improve load estimates and integrate with tidal monitoring.
  - consider designing systems of ground-water observations in the coastal plain that can be used to provide quantitative estimates of nitrate fluxes into segments of the tidal system.

All of these options would improve watershed model calibration in spatial areas including urban/suburban, small basins, coastal plain and other spatial gaps (MRAT 2009).

There is also a need to improve data management of the information in the network through developing a web-based tool for submitting, tracking, and evaluating network stations. The gages incorporated into the network are currently funded through 2009 although the long-term future of this funding is uncertain. Data providers are addressing the key challenges in organization, coordination, and sampling protocols; these solutions will strengthen the existing network and provide ample justification for expansion in future budget allocations. The lack of additional resources for more monitoring sites will limit the ability of resource managers to assess the effectiveness of management actions to improve water-quality in the watershed and the tidal waters of the Bay.

References

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Fig. 1 Active non-tidal water-quality monitoring network sites in the Chesapeake Bay Watershed, calendar year 2009